



# FOREST HEALTH PROTECTION Pacific Southwest Region

Report No. SS09-05

Jan 15, 2009  
File No. 3420

## **Biological Evaluation of Insect and Disease Conditions in the Teton Fuels and Forest Health Project 2 Summit Ranger District Stanislaus National Forest**

**Summary of recommendations.** *FHP reaffirms previous evaluations in the Teton project by John Pronos (vice FHP pathologist) in 2001 and 2004, are still appropriate. We suggest that an Integrated Pest Management approach to this project's multiple insect and disease problems be adopted. We suggest that managers go through a progression of evaluations: by first evaluating the best solution to root disease problems, and then modifying this solution to mitigate mistletoe presence. Environmental conditions may change before treatments are initiated, and bark beetles could quickly become the major problem. Additionally there will always be an additional layer of responsibility relating to Hazard Trees. We strongly recommend the blanket application of the Regional Office policy on the use of borate treatments in all recreational settings.*

### **Introduction**

At the request of John Nelson (District Forest planner), Forest Health Protection (FHP) South Sierra Shared Service (Beverly M. Bulaon, Joel M. Egan, and Martin MacKenzie) was asked to conduct a detailed evaluation of insect and disease conditions in the Teton Fuels and Forest Health Project 2.

The Teton project is located along the Clark Fork River and encompasses over 1000 acres for potential treatment. At 5500 to 6200 feet elevation throughout the project, most of the stands are predominantly composed of Jeffrey pine (*Pinus jeffreyi*), red fir (*Abies magnifica*), and incense cedar (*Calocedrus decurrens*) with scattered Douglas fir (*Pseudotsugae mensizeii*). Lodgepole pines (*Pinus contorta*) were found in small clusters at the highest elevation sites intermixed with a few western junipers (*Juniperus occidentalis*). Trees within campground were primarily of very large diameter, with some poles and few seedlings. Trees have had difficulty surviving to maturity as the smaller trees were constantly being run over by vehicles



Healthy Forests  
Make A World  
Of Difference

**SOUTH SIERRA SHARED SERVICE AREA  
USDA Forest Service, 19777 Greenley Road  
Sonora, California 95370 (209) 532-3671**

or trampled by feet. Trees were widely spaced between campsites and facilities, but there were small islands of a few trees scattered about. In the natural stands, the opposite was true: stand structure was multistoried and dense. Firs and cedars made up 80% of the understory regeneration, while pines and firs were an even mix in the overstory.

The project is to treat six heavily used campgrounds, several day-use areas, and the main road corridor that accesses all sites. The project was submitted back in 2006 under a categorical exclusion to reduce wildfire ignition potential and hazards. However, the project was appealed and an EA was initiated. The severe wildfire threat along the main Clark Fork road is still real, and the same fuel reduction treatments are planned, this time along with additional forest health objectives.

### **General Observations.**

Two previous evaluations by John Pronos in 2000 and 2004, covered much of the same ground as the current Teton Project. The same locations were evaluated and any changes in insect and disease conditions are noted in this report. Since the earlier reports were written, Elytoderma needle disease (*Elytoderma deformans*) on pines is not as obvious as it was in 2000. However, the impacts of both Annosum root rot (*Heterobasidion annosum*) on firs and White Pine Blister Rust (*Cronartium ribicola*, WPBR) on sugar pines were more obvious than previously.

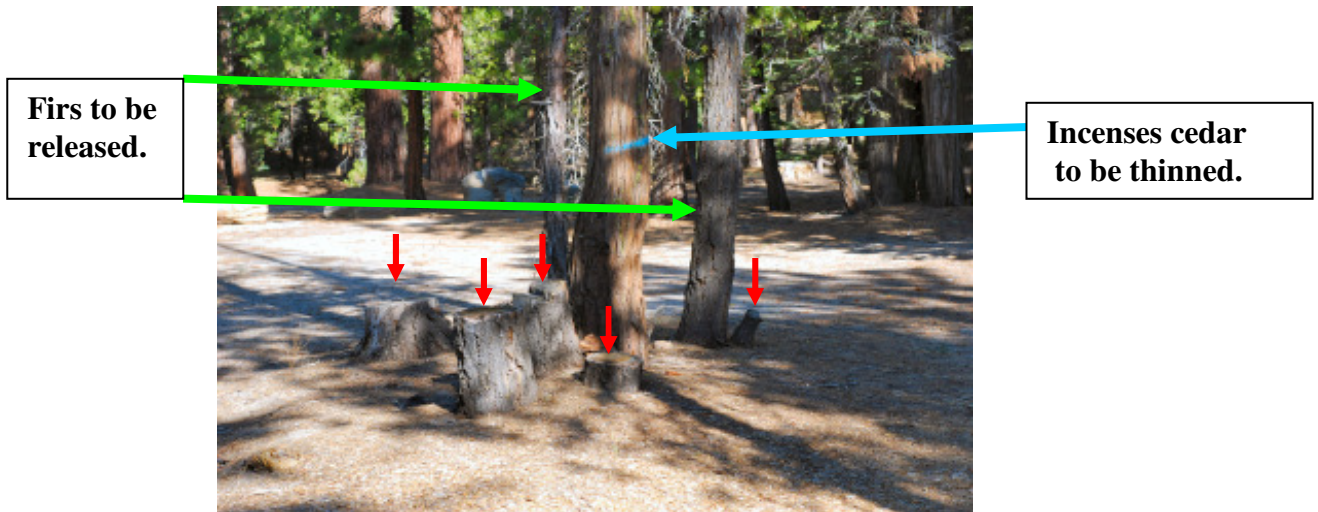
As with the previous reports, the western dwarf mistletoe (*Archeuthobium campylopodum*) parasitizing Jeffrey pine is currently the most serious pest problem. However, as noted by Pronos (2004), bark beetle activity can be expected to recur periodically in stands that are stressed by overstocking, dwarf mistletoe infections, Annosum root disease, and intermittent drought conditions. Initial bark beetle attacks are frequently associated with interactions of these stressors. In our observations of the campgrounds, we observed Jeffrey Pine beetle (*Dendroctonus jeffreyi* = JPB) on Jeffrey pine, mountain pine beetle (*Dendroctonus ponderosae* = MPB) from Lodgepole pine, and fir engraver (*Scolytus ventralis*) on white fir (*Abies concolor*). Given a protracted period of local drought conditions (combined with one or all other stressors) any one of these bark beetles could become the dominant pest problem in the Teton Project area. Currently, populations of these bark beetles are at non-threatening, background levels.

While the bark beetles have the greatest potential to make a dramatic change in the health of the Teton project area, and the mistletoes (especially the western dwarf on Jeffrey pine) are still the most visible problem. Managing Annosum root disease is the problem should be the first step in an Integrated Pest Management (IPM) solution. We believe the campgrounds can survive for several years given the current levels of most of the insects and diseases, with the exception of the annosum root rot. Active management of annosum root disease is essential to extend the usable life of these campgrounds; additionally, treatment of dwarf mistletoes is also highly desirable.

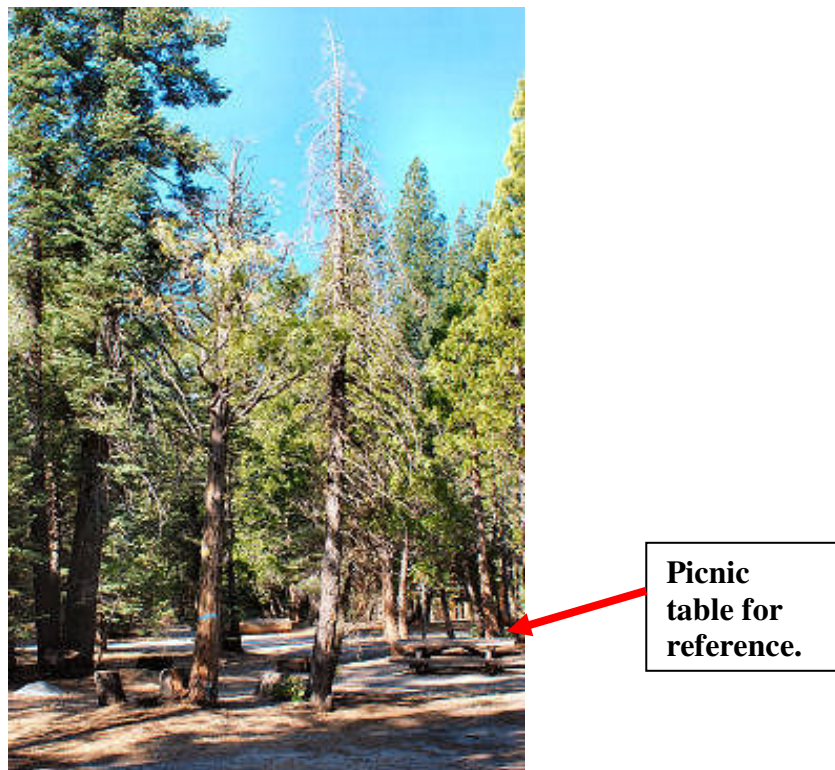
## Assessment of annosus root disease.

### *Photo Essay I*

We will make our assessment by a series of images 1 - 6 that show examples of issues located in the Teton project. Figure 1, shows an earlier marking for thinning. From this photograph it can be seen that five fir trees have already been cut and an incense cedar is marked for thinning, so as to release the two firs (in the background). However, if we step further back and view this cluster of trees, we will have the view in figure 2.



**Image 1.** *Photo essay I.* Thinning of cedar to release fir in a cluster of fir stumps.



**Image 2.** *Photo essay I.* The tree marked for removal (the incense cedar) is the healthiest tree!

It becomes immediately obvious that at least one of the fir trees, once intended to be released, is now dead and the incense cedar is in poor health. In this case, we could cut all of the trees and rely on the adjacent pines to provide the shade and screening required in this campground. Scanning around these same trees, we obtain images 3a & 3b (note the picnic table in both images 2 & 3a).



**Image 3.** *Photo essay I.* The adjacent pine tree, that might have been the replacement tree for the firs and cedars (in images 1 & 2) is itself heavily infested with dwarf mistletoe.

The replacement Jeffrey pine is already heavily infested with dwarf mistletoe and would be a poor candidate to leave on site. Any management solution that is accepted must take into account *all* pest agents plus drought. As a final image in this series is image 4, as an example of what a “no action” option could lead to (under the worst possible case scenario). Eventually all of the trees could die due to their observable levels of infection. With no restrictions on public parking or access, regeneration will be trampled by foot and wheels, leaving no screening for permanent structures.



**Image 4.** *Photo essay I* Under a worst case scenario, all of the trees in images 1-3 could die and the trampling of regeneration could lead to a total loss of all screening vegetation.

### **Photo Essay II**

If this second photo essay (images 5 & 6) had a title it would be: “**trees that share a root system share a disease!**” Image 5 shows a single fir stump and a cluster of trees marked for thinning. A closer look at the lone fir stump (image 6) reveals why we would recommend a remarking of trees to be thinned.



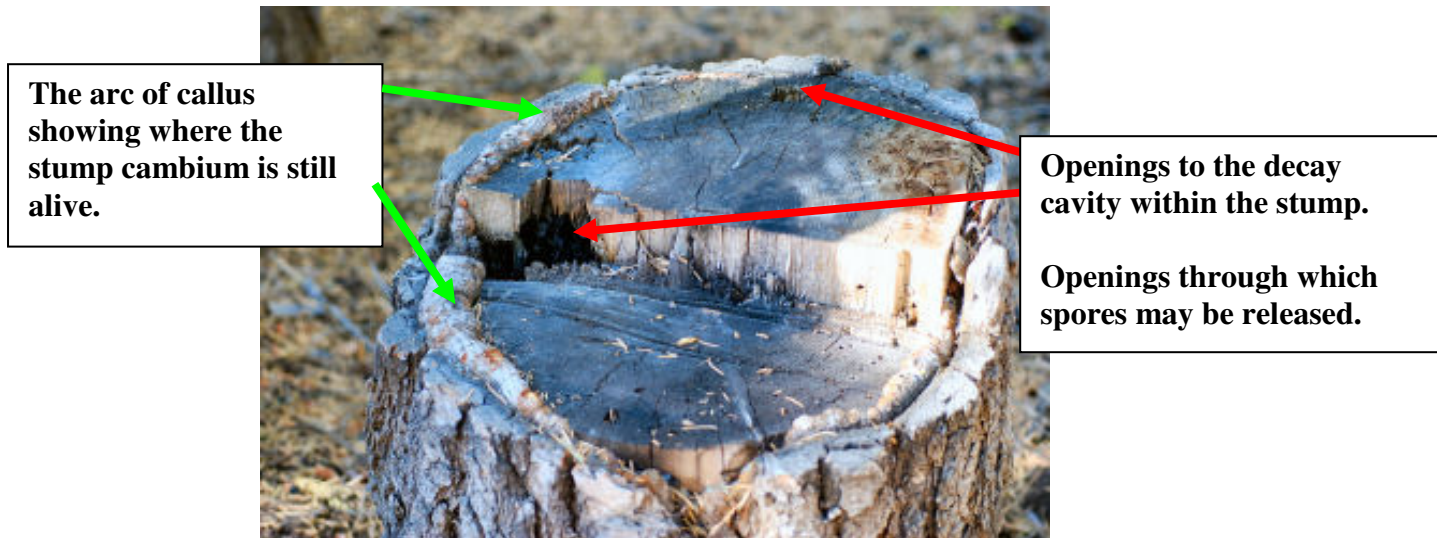
**Image 5.** *Photo essay II* A second cluster of trees marked for thinning to release residual fir. The annosum resistant cedars are marked for removal and the annosum susceptible firs are being retained.

Upon close examination of the stump in the foreground (in images 5 & 6), we found that the stump was alive. Callus tissue, developing on a portion of the circumference and beginning to overgrow the cut surface, is proof that at least a part of the stump cambium is alive. The cambium is alive because the stump is root grafted to at least one of the adjacent fir trees. On peering into the cavity in the stump, an annosus conk could be detected. Conks are the reproductive structures of the annosum fungus. Conks produce spores that are carried in the wind currents and deposited on other freshly cut stump surfaces to initiate new infections.

Unlike the commonly encountered major bracket fungi, annosum root disease produces its conks within a decayed stump. The artists conk (*Ganoderma applanatum*), the redband fungus (*Fomitopsis pinicola*), or the Quinine conk (*Fomitopsis officinalis*), all produce their conks on the outside of a tree or stump, but *Hetobasidion annosum* produces its conks within stumps. While the other fungi have robust conks with upper surfaces that do not readily lose water, the annosum conk is relatively delicate and susceptible to water loss. Thus it forms conks within the shelter of the decay cavity it produces within the stump. By the time the fungus is ready to release spores the roof of the decay cavity is usually beginning to collapse (i.e. the upper surface of the stump has begun to fall away and provide an opening through which spores can be released into the environment beyond the stump). This appears to be an inefficient way to spread fungal spores. While producing its spores in a cavity might seem inefficient and not likely to be very successful, it does have one selective advantage. In the heat of summer, when the humidity is too low, the bracket fungi are not producing spores and yet *H. annosum*, protected within its cavity can continue to produce spores. The only other

decay fungus that has adopted this strategy is the pouch fungus, *Cryptoporus volvatus*. In the case of the pouch fungus the spores are produced and released within a cavity that is made of fungal tissue.

Despite having what appears to be an inefficient means of spreading its spores, *H. annosum* has, in firs at least, another and more efficient means of spread. In firs, the fungus grows down the roots, out of the stump, through the root graft and into any tree that shares a root system with the stump. Thus trees that share a root system have the potential to share a disease.



**Image 6.** *Photo essay II.* A close up of the stump in image 5 showing zone of callus indicating this stump is grafted to at least one of the surrounding firs. .

Looking back at images 1 and 5, it can easily be imagined that we are looking at one root rot pocket in which all of the root grafted firs are dead or dying (image 1). In the other scenario, where we have evidence of root grafting (image 5), the firs have yet to die. Returning to the thinning markings in image 5, it can be seen that at least three incense cedars have been marked for thinning. The marking is incorrect, and the firs should have been marked for removal, while the incense cedars should have been retained.

The seminal study on the genetics of *Heterobasidion annosum* was conducted in Finland by Korhonen (1978), who divided the fungus into 2 types or mating groups, one he called the “P” type and the other the “S” type. The “P” type was recovered from pines, predominately Scots pine (*Pinus sylvestris*) and the “S” type was recovered from Norway spruce (*Picea abies*). Hence the “P” type is the pine type and the “S” type is the spruce type. This typing has held up in North America and the “P” type is a pathogen of Pines (plus incense cedar and juniper) and the “S” type is a pathogen of true firs (Chase, 1989). In our observation of the Teton project we never encountered any evidence of annosum root disease of a single pine. However, we looked at many more fir than pine stumps. Because root grafting in firs is so common, there were more dead firs than pines. Failure to find annosum conks in a pine stump should not be taken as evidence of absence of the “P” type annosum. We suspect the “S” type annosum is much more common than the “P” type.

#### Hosts for the “S” type annosum

True firs  
Douglas fir (in OR, WA & ID)  
Giant sequoia  
Spruce  
Hemlock  
Western red cedar

#### Hosts for the “P” type annosum

Pine species  
Incense cedar  
Juniper

*NOTE: Black Oak (Quercus kelloggii) is a host to neither annosum type.*

Knowing which fungal strain kills which host, makes it possible to formulate simple marking guidelines that can be incorporated into a general strategy for revitalizing and restoring campgrounds within the Teton project. In general, if the evidence supports the concept of an “S” type annosum pocket, thinning should favor the resistant “P” type hosts (plus black oak), and vice versa – provided there is no overriding mistletoe, bark beetle, or other disease concerns. Guidelines for thinning must be site specific, and based upon observations of past and present mortality on the individual sites. If the situation involves only pines killed by bark beetles (image 7), campsite thinning (if needed) would not have to consider the implications of annosum root disease, but instead consider dwarf mistletoe infections. Should the individual camp site in need of thinning, have numerous fir stumps (image 1 & 2) the marking should discriminate against fir, favoring pines and incense cedar. It must be remembered that *H. annosum* is essentially a pathogen of conifers, while black oaks are immune and should be retained in annosum pockets. Black oaks and other non-hosts may be considered for planting if the site is suitable. However, any strategy to deal with annosum root disease must also incorporate a solution to the mistletoe problem, as well as recognize the possibility that these two problems may be combined with drought conditions. If so, then the bark beetles will become of paramount consideration. Any management strategy adopted must be flexible enough to accommodate changing circumstances.

Currently there are three generally accepted methods to combat annosum root disease and only two of these, borate treatments and favoring resistant species are applicable in the Teton project. The three options are outlined below.

**a. Borate treatment.** Treating freshly cut stumps with an approved borate fungicide will prevent new disease centers from starting. However, this has no effect on established centers. It is current Regional policy to apply a borate treatment to all cut stumps in a recreational setting, which all of the Teton project is. Based on the amount of annosus root disease we observed, the continued use of borax is important and justified. Even although we never found an annosus conk in a pine stump, we do not support deviating from the Regional policy of treating all stumps.

**b. Favor resistant species.** Our observations suggest that the dominant (if not the only) annosus fungal type in the Teton project is the “S” type which will only infect true firs and possibly giant sequoia. Pines, incense-cedar, and hardwoods are not hosts for this type. Favoring or planting these resistant species is appropriate especially within or near identified or suspected root disease sites.

**c. Isolate known disease centers.** By removing all white fir within a root rot pocket and additionally harvesting the two edge trees of the pocket it is theoretically possible to limit the spread of the disease. All cut stumps must be borate treated and the perimeter of the pocket should be deep ripped to sever all root to root contact between the edge trees and the first residual living tree. Finally the cleared root disease center would have to be replanted with non-hosts. Clearly this kind of treatment is not generally applicable in a recreational setting and should not be considered for the Teton project. However, were there to be minor realignment of campground roads they could be moved to provide barriers, as root grafts could be broken when realigning roads and if new roads were put along the margins of existing pockets the sacrificed trees would presumably be the infected asymptomatic trees marking the edge of the pocket. Roth *et al* (1977) proposed a similar strategy for dealing with the expansion of *Armillaria* root rot centers.

#### *Dwarf and true mistletoe management*

While criteria exist to guide selection of trees to prune and general guidelines for pruning are available (e.g. Bedker *et al*, 2003) a more relevant treatment is available in Pronos (1981). Since Pronos (1981) is an unpublished FPM report, the mistletoe control program he suggested has been reprinted here as Appendix A. Pronos (2000 and 2004) provided an in depth discussion on mistletoes, all of which we support. Rather than repeat a discussion that is centered on a single stressor, we will make our recommendations for an Integrated Pest Management strategy that considers all indicated pest agents.

#### *White Pine Blister Rust (*Cronartium ribicola*) of Sugar Pine (*Pinus lambertiana*)*

In an earlier report Pronos (2000) mentioned seeing two sugar pines and that one of them had lethal rust infections. While we never saw any lethal rust infections, we did observe flagging we would attribute to the rust. Like Pronos (2000), we strongly urge the planting of rust resistant sugar pine. In areas where there are heavy infections of western mistletoe on Jeffrey pine, sugar can still be planted since it is not infected by the western dwarf mistletoe. Sugar pine has its own mistletoe, *A. californicum*, to which Jeffrey pine is immune (Hawksworth and Wiens (1996). As with the discussion on annosum root disease, WPBR can not be discussed without reference to the other stressors and tree species. We support planting rust resistant sugar pines to increase the biodiversity of the site.

#### *Elytroderma needle cast (*Elytroderma deformans*).*

While Pronos (2000) makes significant mention of *Elytroderma* needle cast, we did not observe significant amounts of this disease. Despite us not observing the fungus, it should be considered for like the bark beetles a change in local climate could bring this pest to the fore again. As the historical record for this disease exists, we must be mindful of it.

### *Hazard Trees.*

While visiting the campgrounds we observed numerous dead trees that constitute potential hazards to the camping public (see image 7 below). The District is also aware of these problem and is planning take them down before they decay and become an imminent problem. We observed large Jeffrey pine killed by JPB, fir killed by fir engraver, and (as photographed below) lodge pole pine killed by MPB. We fully expect these low levels of tree mortality to continue as long as the beetles remain at background levels. We can not stress strongly enough that all “Hazard Tree take downs” involving living (but declining) trees involve the application of a borate treatment in accordance with the Regional Office policy.



**Image 7.** While an integrated pest management approach is recommended, in this case the mortality was caused by Mountain Pine Beetle and there was no mistletoe or root rot component. This is a simple Hazard Tree situation, in which a stump borate treatment is strongly recommended.

### **Recommendations for an Integrated Pest Management strategy**

We suggest an Integrated Pest Management strategy be developed for the Teton Project. There was nothing that we observed in the field that would drastically contradict the general strategies outlined in the proposal. We have outlined a thinning marking strategy that first considers the evidence of annosum root disease and then looks at the mistletoe infestations before making a marking selection. But should there be an outbreak of *Elytroderma* needle cast disease in the spring, or a bark beetle outbreak in the summer the strategy should be changed to meet the changing conditions. In a similar manner, plantings should first be dictated by the evidence of past annosum attack. In “S” annosum pockets only “P” host species should be planted. Once the planting group has been selected, the species selection

should be determined by the surrounding load of mistletoe seeds. If the surrounding Jeffrey pines have mistletoe, the plantings should be sugar, lodgepole, incense cedar, juniper or black oak. Black oak and incense cedar are two species we recommend retaining where possible, as they have resistance to most of the insects and disease mentioned in this report. They should be considered when selecting which species to plant or retain. After marking trees for thinning, attention should be turned to pruning for mistletoe mitigation. While this is an expensive strategy, it could be considered for trees with a DMR of 3 or less. However, for high value trees that have a DMR of 4 or more, pruning might still be justifiable. Because the number of variables considered produces a large number of possible outcomes, we have provided the Pronos (1981) guidelines as appendix A, and recognize that a pruning prescription will have to be made on a site by site basis.

As this project has the potential to be a good example of an Integrated Pest Management approach, FHP would like to be involved in documenting the project, especially the aspects of mistletoe pruning. We believe the Teton Project has the potential to be a showcase of IPM, and a well documented record will be of value to the Stanislaus National Forest when considering future IPM projects.

Forest Health Protection in the South Sierra Service Area strongly supports this project as it emphasizes forest health improvements in conjunction with other management objectives. Ultimately a vegetation management plan for the Teton project is desirable in which to outline future desired conditions and contingency plans outlining how these conditions will be reached and sustained. Additionally, this plan is required for Forest Health Protection funding opportunities in recreation areas. If you have any questions or would like to discuss further details for treatments, please feel free to contact us at 209-532-3671.

/s/ Beverly M. Bulaon  
Entomologist

/s/ Joel Egan  
Entomologist

/s/ Martin MacKenzie  
Pathologist

## **References**

**Bedker, P. J., J. G. O'Brien, M. Mielke and J. Janke. (2003).** How to Prune trees. USDA Forest Service, NA FR-01-95

**Chase T. E. (1989).** Genetics and population structure of *Heterobasidion annosum* with special reference to Western North America. In Proc of the Symposium on research and management of Annosus root disease (*Heterobasidion annosum*) in North America. USDA Forest Service, General Technical Report PSW GTR-116. pages 19-25

**Hawksworth, F. G. and D. Wiens. (1996).** Dwarf mistletoes: biology, pathology, and systematics. USDA FS AG handbook # 709 409pp.

**Korhonen E. (1978).** Intersterility groups of *Heterobasidion annosum*. Communicationes Instituti Forestalis Fenniae 94:1-25

**Pronos, J. (1981).** An evaluation of dwarf mistletoe in Cedar Grove campground. USDA Forest Health Protection, FPM report #81-11

**Pronos. J. (2001)** Evaluation of dwarf mistletoe in the Teton timber sale, Clark fork area, Summit Ranger District, Stanislaus National Forest. USDA Forest Service, Forest Health Protection, FPM Report # C01-1. 6pp.

**Pronos. J. (2004).** Dwarf mistletoe infestations at Sand Flat campground, Summit Ranger District, Stanislaus National Forest. USDA Forest Service, Forest Health Protection, FPM Report #C04-3. 6 pp.

**Roth, L. F., C. G. Shaw III, and L. Rolph. (1977).** Marking Ponderosa pine to combine commercial thinning and control of Armillaria root rot. Journal of Forestry 75(10):644-647.

**Appendix A..** “Procedures for Dwarf Mistletoe Control Programmes.” Taken from Pronos, J. (1981). *An evaluation of dwarf mistletoe in Cedar Grove campground*. FPM report #81-11.

Procedures for Dwarf Mistletoe Control Programmes:

1. Removing infected overstory trees to protect regeneration.
2. Removing witches’ brooms from trees.
3. Removing infections by pruning.
4. Removing heavily infected trees.
5. Thinning to remove infected trees and release residual trees
6. Creating buffer strips.
7. Favoring resistant species (including planting).
8. Destroying heavily infested stands and revegetating from scratch.

The first step for a control program for campground is to map the areas of infestation. The each infected tree must be examined to decide whether to remove the mistletoe or to remove the entire tree. In making these decisions the guidelines below should be used. High-value trees and special situations may require deviations from these generalizations. However, deviations should be kept to a minimum in order to maintain treatment effectiveness.

**(1a).** Trees with a DMR of 3 or less-prune off all the lower branches, both healthy and diseased, at the bole and up to and including the second whorl of branches above the highest visible infection. Experience has shown that removing branches only up to the highest infection or even one more whorl almost certainly results in latent infections appearing in 3-5 years.

**(1b).** Trees with a DMR of 4 , and no mistletoe in the upper 1/3 of crown-prune to remove infections or take out depending upon the condition of, crown, tree vigor, distribution of mistletoes , and importance of the tree.

**(1c).** Trees with a DMR of 5 or 6 remove.

**(2).** A tree should have at least 30% live crown after pruning.

**(3).** Whenever possible avoid removing more than 50% of a tree’s live crown.

**(4).** Bole infections. If the stem diameter at the point of infection is less than 6 inches, remove the tree. Bole infections are not serious from the stand point of spreading mistletoe but they deform and / or lead to mortality in small trees.

**(5).** Branches 1 inch or less in diameter with mistletoe plants within 6 inches of the bole are not prunable because the parasite is probably already in the bole. For each 1-inch increase in branch diameter, the minimum safe distance for pruning increases by 2 inches.

(6). Removing witches' brooms from large high-value trees will increase vigor of the trees. It may not be possible or acceptable to remove all additional branch infections.

(7). Some infections may be left in desirable isolated trees where there are no susceptible trees within range of remaining mistletoe shots/ seeds. This is often the case when broom pruning is used.

(8). In very dense aggregations it is often best to thin out infected trees even although they are prunable. Make decisions based on tree vigor, spacing, and expected response of residual trees.

(9). Buffer zones are defined as areas free from susceptible hosts, are essential to prevent mistletoe from re-entering the control area. Examples include meadows, roads, rivers, clearings, and plantations of non-host trees. Construction of new roads, structures or campsites can also be used to create buffer zones.

(10). Definitely plan to re-enter and treat campgrounds in 3-5 years to remove previously undetected latent infections. Dwarf mistletoe can not be eliminated with one stand entry.

Remembering always that mistletoes are but one of many pests that impact the health of forest trees, and a mistletoe control plan should be drafted while considering all pests and should be included within a comprehensive vegetation management plan.